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Indian Standard

DETERMINATION OF THE LUMINANCE DISTRIBUTION OF ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIERS

UDC 621·3 + 615·47 621·386·842·001·11 535·37·083·001·2

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NEW DELHI 110002

September 1993 **Price Group 5**

Electromedical Equipment Sectional Committee, MHD 19

NATIONAL FOREWORD

This Indian Standard which is identical to IEC Pub 572 (1977) 'Determination of the luminance distribution of electro-optical X-ray image intensifiers (First edition)', issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendations of the Electromedical Equipment Sectional Committee (MHD 19) and approval of the Medical Equipment and Hospital Planning Division Council.

The text of IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in the Indian Standard. Attention is particularly drawn to the following:

> Wherever the words 'International Standard' or 'IEC standard' appear referring to this standard, they should be read as 'Indian Standard'.

Only English language text in the International Standard has been retained while adopting it in this Indian Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

NOTE — Reference to IEC 572/1977 in clause **6** of the adopted standard should be read as reference to this standard, that is, IS 13729 : 1993.

IS 13729 : 1993
IEC Pub 572 (1977)

Indian Standard

DETERMINATION OF THE LUMINANCE DISTRIBUTION OF ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIERS

1. Scope

This standard defines the method for determining and indicating the LUMINANCE DISTRIBUTION of ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIERS.

The LUMINANCE DISTRIBUTION will be determined from the measurement of the luminance over the area of the OUTPUT IMAGE related to conditions of uniform EXPOSURE RATE in the ENTRANCE PLANE of an ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIER.

2. Terminology

2.1 *Degree of requirements*

In this standard the auxiliary verb

- shall implies that compliance with a requirement is mandatory for compliance with the standard;
- should implies that compliance with a requirement is strongly recommended but is not mandatory for compliance with the standard;
- may implies that compliance with a requirement is permitted to be accomplished in a particular manner, for compliance with the standard.

Note. – These definitions are under consideration.

2.2 *Definitions*

2.2.1 *Luminance distribution*

The spatial variation of luminance over the area of an OUTPUT IMAGE of an ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIER under SPECIFIC conditions.

2.2.2 *Optical output plane*

The plane apparently containing the OUTPUT IMAGE of an ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIER, taking into account the shortening of the optical distance through the total intervening glass covers.

2.3 *Further definitions*

Definitions of terms used, but not defined, in this standard are given in Appendix A.

3. Measuring conditions

3.1 *General requirements*

For the measurement of the LUMINANCE DISTRIBUTION, the operating conditions of the ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIER, for example the anode potential, the focusing potentials and the demagnifying ratio shall be adjusted according to the manufacturer's instructions for normal use as given in the ACCOMPANYING DOCUMENTS, referring especially to the diameter of the OUTPUT IMAGE.

3.2 *Beam of radiation*

3.2.1 *Alignment of the X-ray tube*

The X-RAY TUBE and the X-ray image intensifier shall be positioned to each other such:

- that the FOCAL SPOT of the X-RAY TUBE is on a line through the centre of the maximum USEFUL AREA perpendicular to the ENTRANCE PLANE of the X-ray image intensifier and
- that measurements are made along that diameter of the radiation beam coming effectively from the target under the same angle.

3.2.2 *Focal spot distance*

The distance between the FOCAL SPOT of the X-RAY TUBE and the ENTRANCE PLANE shall be 1000 ± 10 mm.

3.2.3 *Filtration of radiation*

The TOTAL FILTRATION of the incident beam of radiation shall be as indicated in Table I. The distance between the FOCAL SPOT of the X-RAY TUBE and any ADDED FILTERS shall not exceed 300 mm.

3.2.4 *Limitation of the beam of radiation*

The size of the beam of radiation shall be such that the irradiated area is the maximum USEFUL AREA in the ENTRANCE PLANE at a distance of 1000 mm from the FOCAL SPOT to the ENTRANCE PLANE.

The limitation of the beam of radiation shall be made by a DIAPHRAGM placed between the X-RAY TUBE and the ADDED FILTERS necessary to give the required TOTAL FILTRATION. An additional DIAPHRAGM shall be placed immediately in front of the ENTRANCE PLANE.

The thickness of the attenuating materials of the diaphragm system shall be such that the radiation transmitted by these materials does not contribute to the measured value of luminance by more than 1%.

Note. – A test for verification is under consideration.

3.2.5 *Radiation quality*

The incident beam of radiation in the centre of the maximum USEFUL AREA of the X-ray image intensifier shall be adjusted to one of the RADIATION QUALITIES given in the first column of Table I.

It should be adjusted to a RADIATION QUALITY of a HALF-VALUE LAYER of 7 ± 0.2 mm aluminium as given under line b of Table I.

The RADIATION QUALITY shall be obtained by:

- TOTAL FILTRATION as given in the second column of Table I;
- approximate value of the X-RAY TUBE POTENTIAL DIFFERENCE as given in the third column of Table I;
- PERCENTAGE RIPPLE in the X-RAY TUBE POTENTIAL DIFFERENCE not exceeding 10%.

TABLE I

Radiation quality of beam of radiation

	First HALF-VALUE LAYER	TOTAL FILTRATION between FOCAL SPOT and ENTRANCE PLANE	Approximate X-RAY TUBE POTENTIAL DIFFERENCE
a	4 ± 0.2 mm Al	12 ± 0.5 mm Al	53 kV
b	7 ± 0.2 mm Al	22 ± 0.5 mm Al	75 kV
c	10 ± 0.2 mm Al	22 ± 0.5 mm Al	124 kV
d	1.5 ± 0.1 mm Cu	2.2 ± 0.2 mm Cu	150 kV

The reference material and ADDED FILTERS shall be pure aluminium (99.8 %) or electrolytic copper (99.94 %) respectively.

3.3 *Correction for non-uniformity of the beam of radiation*

3.3.1 *Exposure rate*

The X-RAY TUBE CURRENT should be adjusted in such a way that the EXPOSURE RATE measured in the ENTRANCE PLANE is between 25 and 250 nC $kg^{-1}s^{-1}$ (about 0.1 and 1.0 mR s^{-1}).

3.3.2 *Area of measuring device*

The effective area of the measuring device shall not exceed 0.25 % of the maximum USEFUL AREA in the ENTRANCE PLANE or an area with a diameter of 10 mm, whichever is larger.

Note. – A photo-electric method or an analysis of the density distribution of a RADIOGRAM on non-screen film is recommended.

3.3.3 *Arrangement*

Measurements of the uniformity of the beam of radiation shall be made with the effective area of the measuring device in the ENTRANCE PLANE and parallel to it but without the ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIER in place.

3.3.4 *Sensitivity of the measurement*

A relative deviation of ± 2% from the uniformity of the beam of radiation shall be detectable.

3.3.5 *Determination of non-uniformity*

The non-uniformity of the beam of radiation shall be determined along that diameter of the radiation beam coming effectively from the target under the same angle.

If the non-uniformity exceeds 2%, the luminance values of the OUTPUT IMAGE shall be corrected accordingly.

The non-uniformity thus determined shall be within 20% with respect to the highest value of the EXPOSURE RATE.

3.3.6 *Temporal constancy of the exposure rate*

If, during the measurements, the EXPOSURE RATE fluctuates by more than ± 2%, the luminance values of the OUTPUT IMAGE shall be corrected accordingly.

3.4 *Measurement of the luminance*

3.4.1 *Size of the measuring field*

The effective area of the measuring field for the measurements of the luminance shall not exceed the corresponding area in the ENTRANCE PLANE as determined in Sub-clause 3.3.2.

3.4.2 *Arrangement*

The LUMINANCE DISTRIBUTION shall be determined along a diameter of the OUTPUT IMAGE which corresponds to that diameter of the maximum USEFUL AREA which is irradiated by radiation coming effectively from the target under the same angle.

To obtain measurements along different diameters, the X-RAY TUBE and the X-ray image intensifier shall be rotated around the nominal axis of symmetry of the X-ray image intensifier with respect to each other.

The luminance shall be measured in the direction perpendicular to the OPTICAL OUTPUT PLANE.

3.4.3 *Number of measurements*

The distances between successive points of measurement shall be not greater than those corresponding to 10% of the diameter of the maximum USEFUL AREA in the ENTRANCE PLANE.

3.4.4 *Accuracy of the luminance measurement*

A relative deviation of ± 2% shall be detectable. No particular specifications are required with respect to the absolute accuracy of the luminance measurement.

The acceptance cone of the device measuring the luminance shall be small enough to avoid errors when measurement approaches a dark edge.

4. **Determination**

The values of the luminance measured shall be corrected in accordance with the non-uniformity of the beam of radiation along the relevant diameter in the ENTRANCE PLANE.

For this purpose, each measuring point in the OPTICAL OUTPUT PLANE shall be related to the corresponding point in the ENTRANCE PLANE.

5. **Indication**

The LUMINANCE DISTRIBUTION shall be indicated by curves or by a table of numerical values showing the relative luminance as a function of distance along a diameter for one or more diameters through the OUTPUT IMAGE.

The results obtained shall cover a range of at least 90% of the corresponding diameter of the maximum USEFUL AREA in the ENTRANCE PLANE.

If only one diameter is selected for stating the LUMINANCE DISTRIBUTION, it shall be the diameter showing the greatest variation of luminance in the OUTPUT IMAGE.

Unless otherwise specified, the indicated LUMINANCE DISTRIBUTION refers to a RADIATION QUALITY of a HALF-LAYER VALUE of 7 ± 0.2 mm aluminium (see Table I, line b).

6. Statement of compliance

If compliance with this standard for the determination of the LUMINANCE DISTRIBUTION of ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIERS is to be stated, it shall be indicated as follows:

Luminance distribution IEC 572/1977.

APPENDIX A

TERMINOLOGY

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A2. Definitions

The definitions in this appendix are still under consideration. They will be included later in various chapters of the International Electrotechnical Vocabulary. The final approved versions of the definitions may require a revision of the wording of this standard.

The definitions of terms used in this appendix are not necessarily included here. They will be contained in the chapter Medical Radiology of the I.E.V., and are at present under consideration.

A2.1 *Exposure rate*

Letter symbol: $\dot{X}$.

Special quantity for measurement of IONIZING RADIATION: the quotient of dX by dt, where dX is the increment of EXPOSURE in the time interval dt:

$$\dot{X} = \frac{dX}{dt}$$

The unit of EXPOSURE RATE is the coulomb per kilogramme · second.

The special unit of EXPOSURE RATE is the röntgen or its multiple or submultiple per a suitable unit of time.

A2.2 *Radiation quality*

A quantity indicating a characteristic of IONIZING RADIATION determined by the spectral distribution of a radiation quantity with respect to RADIATION ENERGY.

Note. – For various purposes, practical approximations of RADIATION QUALITY are expressed in terms of variables such as:

a) potential difference with PERCENTAGE RIPPLE and TOTAL FILTRATION,
b) first HALF-VALUE LAYER for specified potential difference with PERCENTAGE RIPPLE,
c) first HALF-VALUE LAYER and TOTAL FILTRATION,
d) the quotient of the first HALF-VALUE LAYER and the second HALF-VALUE LAYER,
e) EQUIVALENT ENERGY.

A2.3 *Half-value layer*

Special quantity indicating a characteristic of IONIZING RADIATION determined by the thickness of specified material which transmits a narrow beam of IONIZING RADIATION to an extent such that the EXPOSURE RATE is reduced to one-half of its original value.

HALF-VALUE LAYER is expressed in the thickness of the layer in suitable submultiples of the meter together with the material.

Note. – A narrow beam implies that SCATTERED RADIATION is excluded as far as possible from the measurement.

A2.4 *Total filtration*

The total of INHERENT FILTRATION and ADDITIONAL FILTRATION between the RADIATION SOURCE and the PATIENT or a defined plane.

A2.5 *Effective focal spot*

The projection of the ACTUAL FOCAL SPOT on a plane perpendicular to a specified direction.

Note. – The shortened term FOCAL SPOT refers to the EFFECTIVE FOCAL SPOT.

A2.6 *X-ray tube*

A high-vacuum hollow vessel for the production of X-RADIATION by the bombardment of a TARGET by a beam of electrons accelerated by a potential difference.

A2.7 *Radiogram*

Permanent record of the information having been contained in the distribution of radiation in a RECEPTIVE AREA.

A2.8 *X-ray image intensifier*

A device which converts an incident X-RAY PATTERN into a corresponding light pattern and needs additional supply of energy for intensification.

A2.9 *Electro-optical X-ray image intensifier*

An X-RAY IMAGE INTENSIFIER in which the fluorescent image produced by IONIZING RADIATION in the INPUT SCREEN is transformed in a vacuum tube by a photocathode into an electronic image and then converted into a light image in the OUTPUT SCREEN.

Note. – This concept includes various types of X-RAY IMAGE INTENSIFIERS:

- X-RAY IMAGE INTENSIFIER TUBES;
- devices equipped with:
  - *a)* LIGHT IMAGE INTENSIFIER TUBES or
  - *b)* other electronic image converter tubes.

A2.10 *Entrance plane*

The plane perpendicular to the nominal axis of symmetry of an ELECTRO-OPTICAL X-RAY IMAGE INTENSIFIER barely touching its most protruding part in the direction of the RADIATION SOURCE.

A2.11 *Output image*

The light image generated in the OUTPUT SCREEN of an image intensifier.

A2.12 *Output screen*

In an electro-optical vacuum device, the layer in which the pattern of electrons is transduced into a light image.

A2.13 *Added filter*

FILTER that can be positioned in, or taken out of, the USEFUL BEAM.

Note. – This includes removable ADDED FILTERS (removable without tools) and fixed ADDED FILTERS (removable only with tools).

A2.14 *X-ray tube potential difference*

The potential difference applied to an X-RAY TUBE between the CATHODE, i.e. the electron emitter, and the ANODE.

A2.15 *X-ray tube current*

The electric current through the ANODE of an X-RAY TUBE.

A2.16 *Percentage ripple*

For an X-RAY GENERATOR, the percentage value of the ratio of:

- the difference between the highest and the lowest value of the rectified high potential difference due to the waveform of the supply voltage,

to

- that highest value.

A2.17 *Useful beam*

From a source of IONIZING RADIATION, all IONIZING RADIATION which emerges through the specified aperture of its PROTECTIVE SHIELDING or of its BEAM-LIMITING DEVICE.

A2.18 *Useful area*

In an X-ray image transfer system, the area from which under specified conditions information contained in the X-ray image is transferred.

A2.19 *Receptive area*

In radiodiagnosis, the active area over which information contained in a beam of incident radiation is detected.

A2.20 *Diaphragm*

A BEAM-LIMITING DEVICE with either a fixed or an adjustable aperture.

A2.21 *Specified*

Used as an adjective in combination with parameters or conditions: referring to a value or arrangement to be chosen and indicated for the purpose under consideration.

A2.22 *Specific (adjective)*

Used in combination with parameters or conditions: referring to a particular value or standardized arrangement, usually to those required in an IEC standard.

A2.23 *Accompanying documents*

Documents accompanying an electrical installation, electrical equipment or ACCESSORY and containing all important information for the assembler, the installer and the user, particularly regarding safety.

A2.24 *Control panel*

A device containing means for manual control of electrical equipment, for pre-selection and indication of operating factors, etc.

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Doc : No. MHD 19 (2404)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Printwell Printers, Aligarh, India